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REDWOOD SEED DISPERSION IN OLD-GROWTH CUTOVERS

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A favorable prospect for abundant sound seed with high viability following harvest cuttings in old-growth redwood (Sequoia sempervirens (D. Don) Endl.) in north coastal forests of California will be good news for forest managers. This conclusion seems warranted from the first year's seed studies on the Redwood Experimental Forest, where the Forest Service is studying old-growth redwood management in cooperation with Simpson Timber Company. Incomplete second year's results strengthen the conclusion and suggest dependability of seed production. On all three kinds of experimental cuttings--selection, shelterwood, and clear cutting--there was more than enough seed for natural regeneration.

The amount of sound redwood seed per acre varied according to numbers of cone-bearing trees and distance from them. More than 4 million sound seed per acre were dispersed in the selection cutting. In the center of the 22-acre clear cutting 200,000 sound seeds per acre reached the ground. And the sound seed was highly viable; an average of 79 percent of it germinated.

METHODS

Seedfall was sampled with one-foot square wire seed traps[1] placed at one corner of each growth plot in selection and shelterwood cuttings and along one transect line in the clear cutting. The arrangement and number of traps used in sampling is illustrated in figure 1.

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[1] Boe, Kenneth N. A one-foot square wire seed trap. Jour. Forestry 53(5): 368-369, illus. 1955.

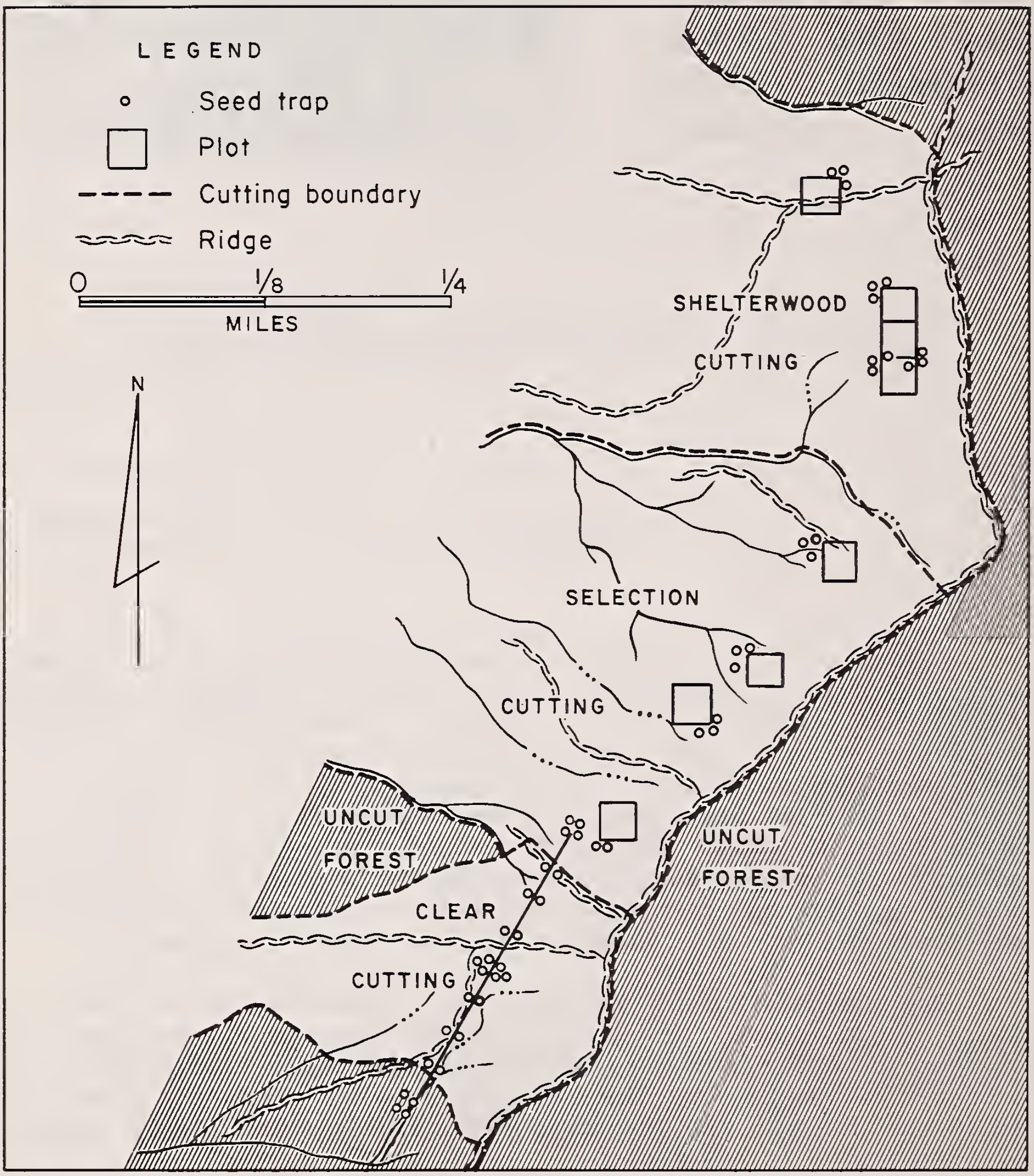

Figure 1.--Location and number of seed traps used to sample seed fall on three experimental cuttings.

At monthly intervals the seed traps were emptied. The seed caught in one trap of each cluster of three in the selection and shelterwood cuttings were saved for germination tests. On the clear cutting, samples for germination were obtained from two traps in each marginal stand and four at the center.

Seed for germination tests were stored dry at room temperature until March 31 when testing began. From the different lots, seed that were judged to be sound by visual inspection were placed on filter paper in glass covered petri dishes. The dishes were placed on an open shelf in a room lighted during the day by indirect sunlight received through northwest and northeast facing windows and by intermittent fluorescent light. The dark period lasted about 11 hours. Room temperature and relative humidity were constant day and night at 69° F. and 62 percent. The filter papers were kept saturated with water but no surplus water was allowed to remain. Germinated seeds were examined and removed from the germinators at weekly intervals.

After 23 days, cutting tests were made on part of the remaining seed. Some partially germinated but mold-covered seeds were removed at this time. They were not counted as germinated seed because we could not determine whether the fungi inhibited germination. Many other seed were found to be empty by cutting tests. A few plump appearing seed were allowed to remain in the germinators for another 19 days, after which all ungerminated seed were cut to determine soundness. Only very few seed germinated between 23 and 28 days, and none germinated after 28 days.

RESULTS

AMOUNT OF SEED

Abundant sound seed were dispersed in the selection and shelterwood cuttings despite the fact that only about 10 percent of the total were sound (table 1). More than 1.4 million sound seed were shed by the shelterwood stand where 3 seed trees were reserved per acre. The selection cutting averaged 14 seed trees per acre and produced more than 4.4 million sound seed per acre.

The 22-acre clear cutting received sound seed in proportion to the number of marginal seed trees and distance from them. The south marginal stand, where the seed trees averaged 20 per acre, produced 3 million sound seed (table 1). The north marginal stand of 12 seed trees per acre yielded 2 million sound seeds per acre. From each timber edge, the seedfall in the clear cutting decreased sharply to an average of 196,000 at the center some 400 feet away. Seed dispersal did not seem to be influenced significantly by any prevailing wind direction. There was a slight trend for sound seed to drop closer to the timber edge than empty seed. At the center of the clear cutting only 4.4 percent was sound, but the sound seed-total seed quotient increased to more than 8 percent at the timbered edge.

Table 1.--Redwood seed dispersed within different old-growth cuttings

Cutting method	Seed trees[1/]	Amount of seed: Total seed	Amount of seed: Sound seed	Sound seed-total seed quotient
	Number per acre	Thousand per acre		Percent
Selection	14	38,072	4,405	11.6
Shelterwood	3	14,653	1,413	9.6
Clear cutting (22 A.)				
South marginal stand[2/]	20	43,451	3,049	7.0
South timber edge	20	24,502	2,722	11.1
132 feet from edge	0	11,456	871	7.6
264 feet from edge	0	12,349	806	6.5
396 feet from edge	0	4,400	196	4.4
264 feet from edge	0	6,904	436	6.3
132 feet from edge	0	11,086	719	6.5
North timber edge	12	19,319	1,045	5.4
North marginal stand[2/]	12	22,934	2,113	9.2

[1/] Dominant, codominant, and intermediate redwood trees 32 to 117 inches d.b.h.

[2/] Seed traps placed within the stand 132 feet from the cutting boundary.

SEASON OF DISPERSAL

Shedding the greatest proportion of sound seed during the winter months is believed to be characteristic of redwood in these northern stands. Over four-fifths of all sound seed on all experimental cuttings was shed during December and January (table 2). Although the relative monthly proportions will be somewhat different during other seasons, the characteristic of winter dispersal seems established and had been reported previously. 2/

VIABILITY

Sound redwood seed has high viability--an average of 79 percent germinated in all lots tested. The range of sound seed germination, or real germination, in 4 lots of seed without pretreatment during a 42-day test period was 68 to 84 percent:

Location	Real germination (percent)
Selection cutting	83.9
Shelterwood cutting	79.8
Clear cutting	
Margin	67.6
Center	72.7
Weighted average	79.1

Peak germination was reached in 14 days.

DISCUSSION

These first results, although tentative, contain information immediately useful for management of old-growth redwood. Their application may be more safely applied to the northern redwood type where it is known that climate, soil, and stand characteristics are similar to those on the experimental forest.

One way of getting new trees after timber harvests is by germination of the natural seedfall on favorable seedbeds. One key factor for

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2/ Siggins, Howard William. Dissemination by wind of seed of important conifers of California. Thesis submitted in partial satisfaction of the requirements for the Degree of Master of Science, University of California. 78 pp., typewritten, illus. 1926.

Table 2.--Seasonal dispersion of sound redwood seed, Redwood Experimental Forest

Period	Selection	Shelterwood	Clear cutting
	Percent	Percent	Percent
October	[1] --	[1] --	[2] 1.3
November	2.4	4.2	0.5
December	20.4	40.0	21.9
January	65.5	51.3	59.9
February	9.6	2.5	12.8
March	1.4	1.6	1.3
April	0.6	0.4	1.6
May	0.1	0	0.7
June-July	0	0	0
Total	100.0	100.0	100.0

[1] Seed traps were placed on October 27 and November 9 and 10, 1959.

[2] Seed traps were placed September 30, 1959.

success is abundant sound seed having high viability. This report presents strong evidence that old-growth redwood cutovers--partially stocked or surrounded with intermediate, codominant, and dominant trees--will receive abundant, sound seed. Although the frequency of good seed crops has not been determined, the crop matured in 1960 on both cutover and uncut stands at the Redwood Experimental Forest was even larger than that in 1959. Because maximum seed dispersal comes in the winter months, a long period is available for seedbed preparation and slash disposal if that proves necessary.

What happens to the seed after it falls is another facet of the natural regeneration process. Some additional optimism comes from a student report [3] which suggests that redwood seed is lightly regarded as food by deer mice (Peromyscus maniculatus rubidus Osgood), the most abundant small mammal found on these cutovers. The tests reported, although too small to be considered conclusive, indicate that caged mice did not relish redwood seeds. Only 4 seeds, including 1 sprouted, out of 200 offered the mice, were eaten. To what extent feeding preference is influenced by the high percentage of empty seed or sprouted seed remains to be determined.

CONCLUSIONS

Indications are that relatively few seed trees in the upper crown classes will produce ample seed. On the partial cuttings an average of only 3 trees per acre, including both codominant and dominant crown classes, was adequate. Clear cuttings may be dependably seeded from marginal timber. But what is the maximum size? Tentatively, as indicated by these results, it is believed that areas beyond 500 to 600 feet from the timber edge will not receive enough sound seed for prompt regeneration. Hence 30- to 40-acre circular or nearly square cuttings are thought to be maximum size until more information is obtained from larger cuttings.

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[3] Patterson, David W. Response of animal populations to logging in the redwood forest region and an investigation into the possible utilization of redwood seeds (Sequoia sempervirens) by animals on the area. W. M. 125 Project. Humboldt State College. 1960.